Civil & Environmental Engineering 141
Design of Steel Structures

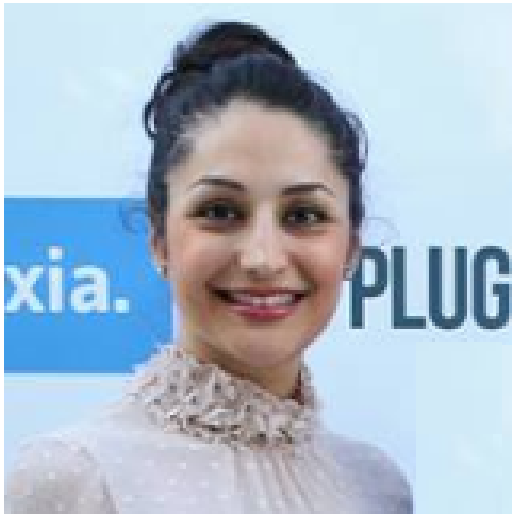
Today's Lecture

- Introductions
- Course Overview
- Introduction to Structural Engineering Practice
- Construction of Steel Structures

INTRODUCTIONS

Instructors

- Kane Pithey, SE - Lecturer
- Elham Moore, PE- TA
- Shahrzad Dastmalchi- TA



Ellie Moore, P.E.
Email: elhammoore@ucla.edu

✧**University of California, Los Angeles**
PhD student in Structural/Earthquake Engineering, *Fall 2014-Present*
✧**University of Southern California, Los Angeles**
Master in Building Science/Structural Engineering, *2010*
✧**Sharif University of Technology, Iran**
Bachelor's in Civil Engineering, *2005*
✧**3rd year TA at UCLA**
✧**8 years of industry experience:** including new building design (i.e. Disney Star Wars Land), seismic evaluation & retrofit of existing buildings, & specialty structures (wind tower foundation)

Shahrzad Dastmalchi
Email: shdstm@ucla.edu

✧**University of California, Los Angeles**
PhD student in Structural/Earthquake Engineering, *Fall 2014-Present*
✧**University of Maryland, College Park**
Master's in Structural Engineering, *2012*
✧**University of Tehran, Iran**
Master's in Earthquake Engineering, *2006*
✧**Iran University of Science and Technology, Iran**
Bachelor's in Civil Engineering, *Fall 2001*
✧**3rd year TA at UCLA**

Kane Pithey

- Licensed Structural and Civil Engineer in California
- 11 years in structural design
- Associate at KPFF Consulting Engineers, LA Office
- BS Civil Engineering from University of Notre Dame
- MS Structural/Earthquake Engineering from UCLA
- Notable Projects: UCSD Outpatient, Sharp Grossmont Hospital, J. Craig Venter Institute, 68th Street School, Southwest Justice Center

HCA Riverside

HCA Riverside

UCSD Outpatient Pavilion

UCSD Outpatient Pavilion

J. Craig Venter Institute

UCLA Terasaki Hall

UCLA Franz Hall Tower

COURSE OVERVIEW

Syllabus

October 1 2018

UCLA Civil and Environmental Engineering

CEE 141 - Steel Structures

Course Syllabus

Fall 2018

Course Description

Lecture, four hours; discussion, two hours; outside study, six hours. Requisite: course 135A. Introduction to building codes. Fundamentals of load and resistance factor design of steel elements. Design of tension and compression members. Design of beams and beam columns. Simple connection design. Introduction to computer modeling methods and design process. Letter grading.

The primary objective of the course is to provide the student with a solid background in the fundamentals of structural steel design. Steel will be used for typical civil engineering structures such as trusses, bridges, and building. Structural design establishes the configuration, details and dimensions. The course addresses the design of individual structural elements (beams, columns, etc.), the connections of structural elements (welded and bolted), and the assemblage of elements to satisfy a specific function. At the end of this course the student will be able to size basic steel elements and connections needed to assemble typical structures.

Posted online on CCLE site

Lecture Format

- Lecture notes posted to CCLE prior to class for use in note taking
- 10 minute break after first half
- Homework due at start of class
- Example problems will be posted to CCLE after lecture

CCLE Web Site

- Lecture notes posted prior to lecture
- Example problems posted after lecture
- Additional readings/references
- Homework assignments & solutions
- Project assignment materials
- Class calendar
- Discussion Forum for assignment clarifications, etc.

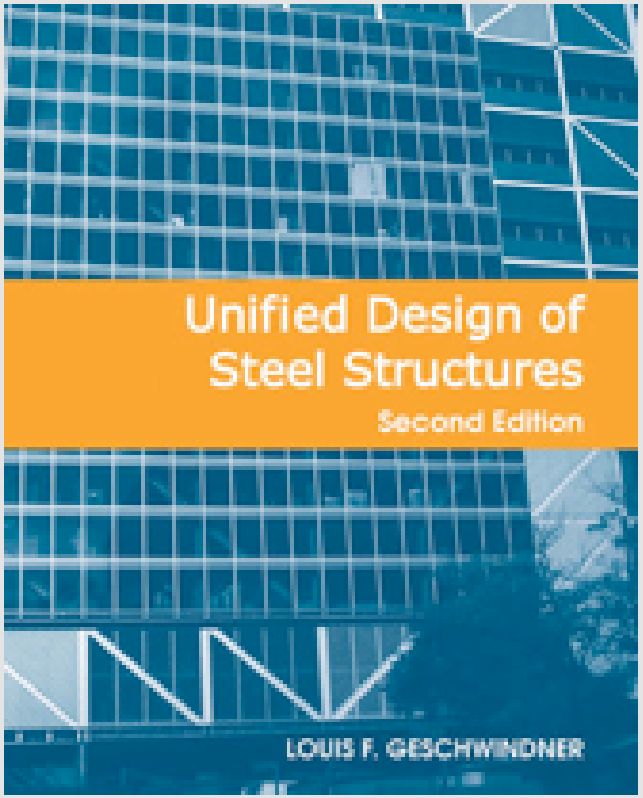
Instructor Office Hours

- Office Hours
  - In Person: Wednesday 10-11 AM
    - 5732 (TBD)
  - Online: Monday 8-9 PM
    - Hosted through GoTo Meeting
    - Recurring invite will be posted on CCLE
- TA Office Hours TBD

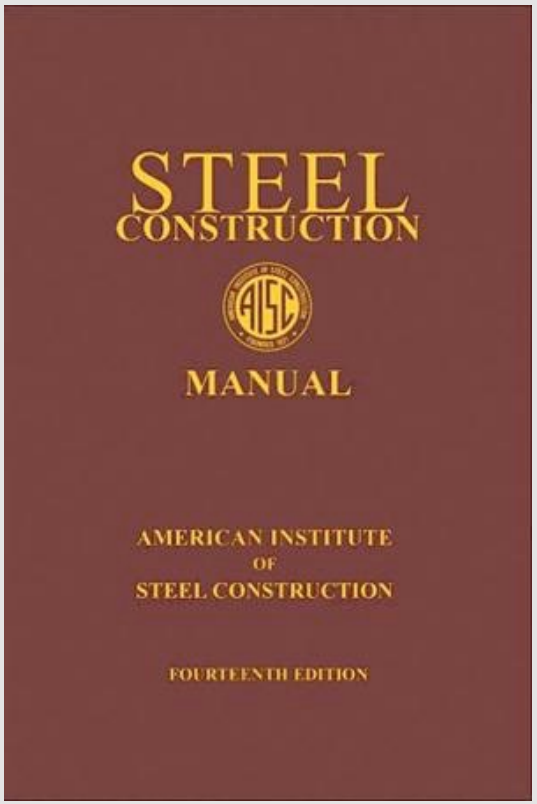
Discussion Forum

- Emailed questions about class material or assignments will not be answered.
- Post these types of questions to the Discussion Forum on CCLE.

Required Texts



"Unified Design of Steel Structures, Second Edition"
Luis F. Geschwindner



"Steel Design Manual, 14th Edition"
American Institute of Steel Construction

Class Schedule

CEE 141
Fall 2018
Class Schedule

UCLA ENGINEERING
Civil and Environmental Engineering

Week	Day	Date	Lecture Topic	Geschwindner Reading	AISC SCM Reference	Homework Assignment	Project Assignment
1	M	1-Oct	Introduction, Structural Engineer Practice, Construction				Pairings, Due 10/5 (CCLE)
	W	3-Oct	Materials and Design Philosophy	Chapter 1 and 2	Parts 1 & 2		
2	M	8-Oct	Tension Members	Chapter 4	Part 5, Chapter D	HW 1, Due 10/15	Groups Assigned
	W	10-Oct	Loads, Load Factors, and Load Combinations	Chapter 2			
3	M	15-Oct	Design Project Overview and Structural Drawings				Inc 1: Column Design, Due 10/23
	W	17-Oct	Compression Members	Chapter 5	Part 4, Chapter E	HW 2, Due 10/22	
4	M	22-Oct	Bending Members 1 (Laterally Supported)	6.1, 6.2, 6.3, 6.7, 6.13	Part 3, Chapter F	HW 3, Due 10/29	
	W	24-Oct	Bending Members 2 (Laterally Unsupported and Noncompact)	6.4, 6.5	Part 3, Chapter F		Inc 2: Roof Framing, Due 11/6
5	M	29-Oct	Midtern Review				
	W	31-Oct	Midtern Exam				
6	M	5-Nov	Composite Beams 1	9.1-9.7	Part 3, Chapter I	HW 4, Due 11/19	Inc 3: Floor Framing, Due 11/20
	W	7-Nov	Composite Beams 2	9.9-9.10	Part 3, Chapter I		
7	M	12-Nov	Composite Beams 3				
	W	14-Nov	Beam-Columns 1	8.1-8.9	Part 6, Chapter H	HW 5, Due 11/26	Inc 4: Wind Girts, Due 12/6
8	M	19-Nov	Beam-Columns 2				
	W	21-Nov	Connections - Bolted	Chapter 10	Part 7, Chapter J	HW 6, Due 12/5	Inc 5: Connections, Due 12/6
9	M	26-Nov	Connections - Welded	Chapter 10	Part 8, Chapter J		
	W	28-Nov	Connections - Eccentric Bolted		Part 10, Chapter J		
10	M	3-Dec	Connections - Eccentric Welded		Part 10, Chapter J		
	W	5-Dec	Final Review				

Schedule will be maintained online on CCLE site

Grading Guidelines

- **Homework 10%**
- **Project 30%**
- **Midterm 25%**
- **Final 35%**

Project

- Will involve the design of steel framing for a building.
- Prepare full-size drawings and calculations.
- Quality of presentation is heavily weighted.
- Will be discussed in detail at 10/15 Lecture.
- **30% of final grade**
- First Assignment: **Due 10/5 (OPTIONAL)**
  - Team up with another student of your choosing
  - Submit your pair online using CCLE by Friday
- Project teams will be randomly assigned groups of 4.

Exams

- Hard copy of Steel Construction Manual will be only reference allowed during exams.
  - Your own handwritten notes within the SCM are acceptable.
- All solutions must utilize the 14th Edition of the SCM.
- Make up exams must be arranged **prior** to the exam dates and will only be accommodated under extraordinary circumstances.

Expectations

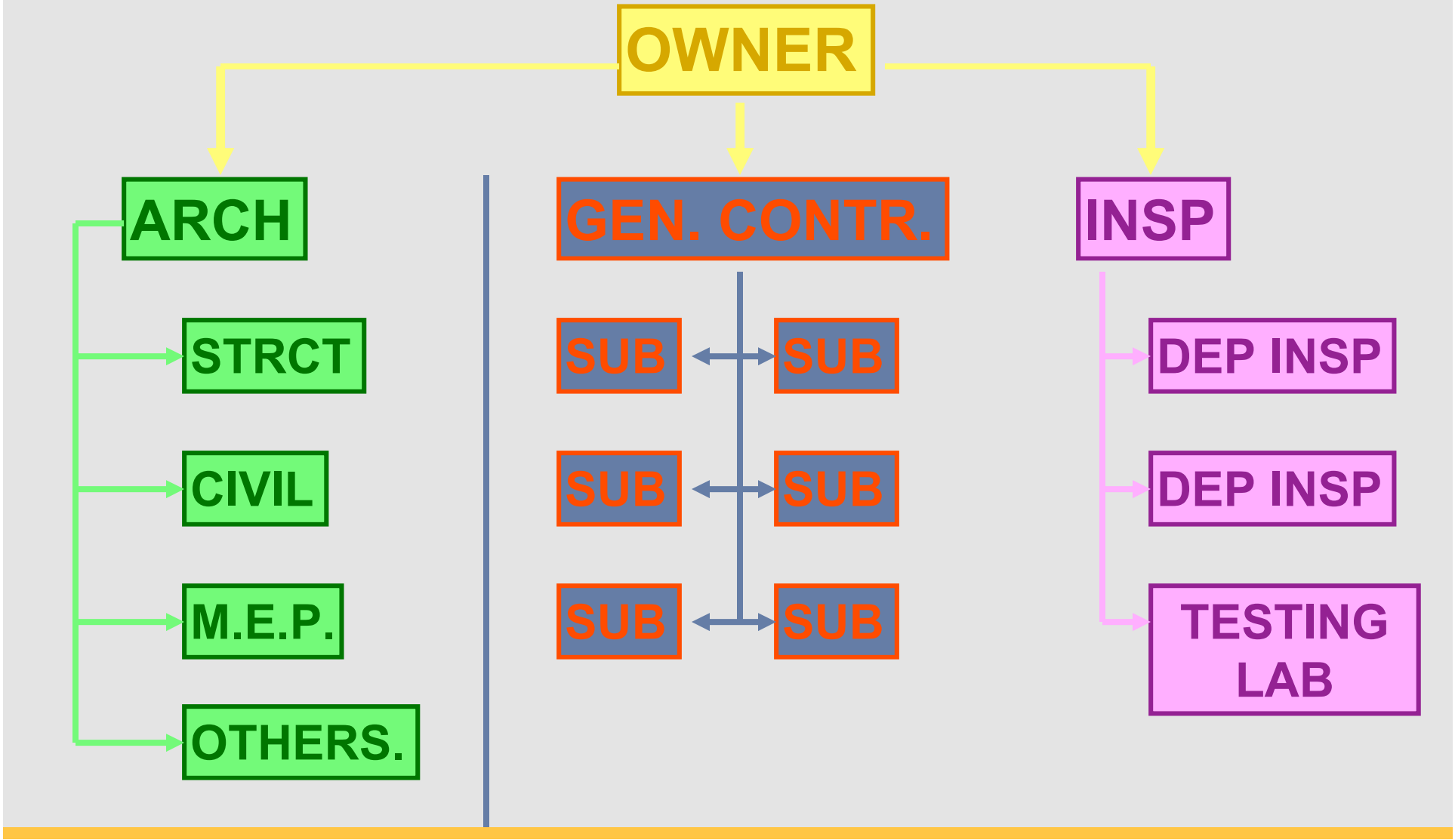
- Read assigned readings prior to lectures
- Attend lectures to listen and learn
- Bring AISC Manual to class
- Learn by doing homework
- Take pride in your project and get an early start
- Clear and logical presentation of your work matters
- Expect to be treated and expect to treat others as a professionals
- HW due at beginning of class
- No late work accepted
- Respect instructors' and TAs' time
- Be brave! Ask questions during class
- Don't rely on the forum for questions! Attend office hours and discussion section

Overview of Structural Engineering Practice

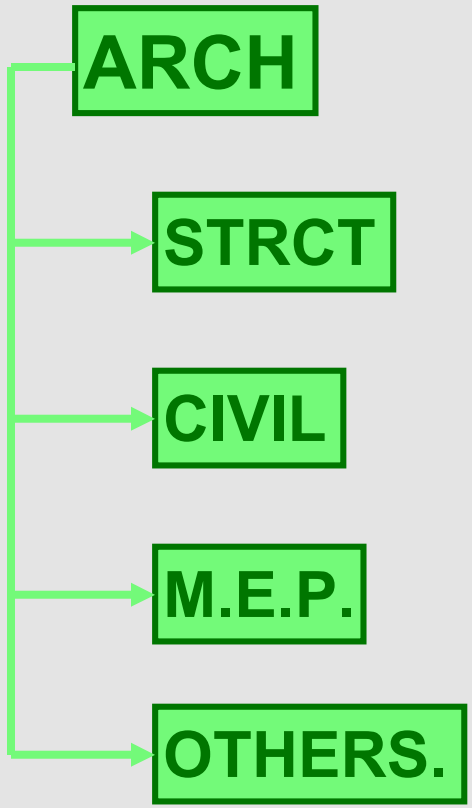
What Does a Structural Engineer Do?

- The structural engineer is part of a team of professionals hired to design or repair a building.
  - The design must be economical.
  - The design must be safe.
- The process of designing and constructing a building is complicated but it is critical to understand the process so you can understand the engineer's role.

Project Structure

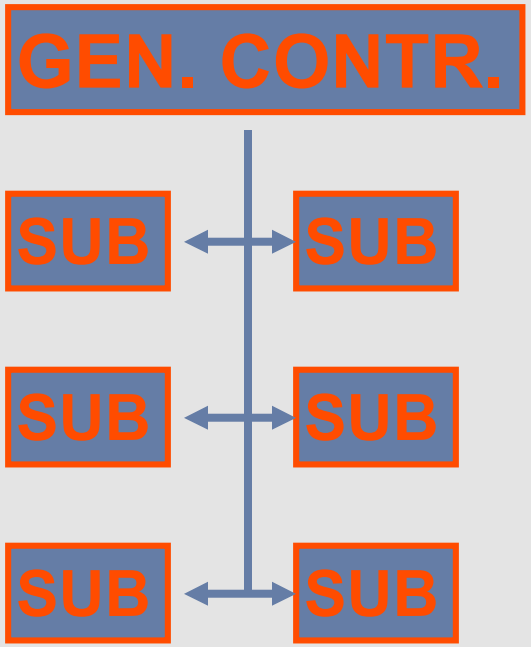


The Design Team



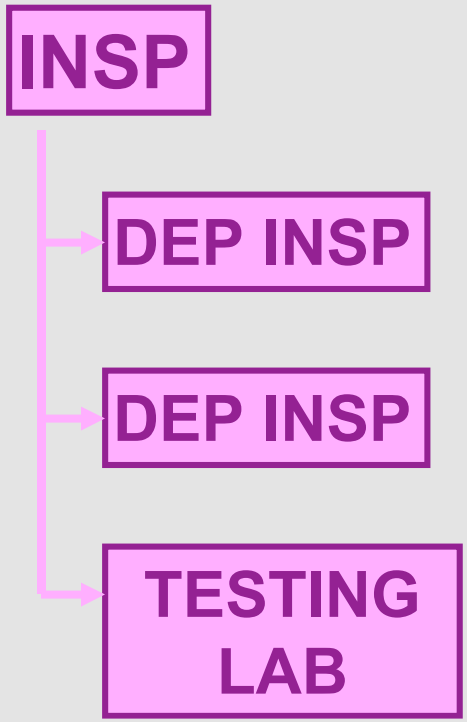
- Architect
  - Primary Contact for Owner
  - Manages the Consultants
  - Overall Design
  - Aesthetics & Program
- Structural Engineer
  - Design of Columns, Beams, Foundations, Braces, etc.
- Civil Engineer
  - Design of Grading & Exterior Piping
- Mech, Elect, Plumbing
  - Air Conditioning, Power, Heating, etc.

The Construction Team



- General Contractor
  - Primary Contact with Owner
  - Primary Contact with Design Side
  - Manages all Sub-Contractors
    - Distributes Information
    - Gives Payments
    - Coordinates Different Trades
- Sub-Contractors
  - Have Special Skills (Carpenters, Iron Workers, Electricians, Welders, etc.)
  - Rarely Interacts Directly with Design Team or Owner

Inspection



- Inspector of Record
  - Hired by Owner to Ensure that Building is Being Built per Plans
  - Oversees the Work of the Contractor and the Sub-Contractors
  - Knowledgeable of Building Construction and Building Code
  - The Design Team's "Eyes" in the Field
- Deputy Inspector
  - Specialized Inspector that Reports Directly to the Inspector of Record
- Testing Laboratory
  - Reports to the Inspector of Record
  - Tests Quality of Materials (Concrete Strength)

THE DESIGN PROCESS AND THE STRUCTURAL ENGINEER'S ROLE

The Structural Engineering Team

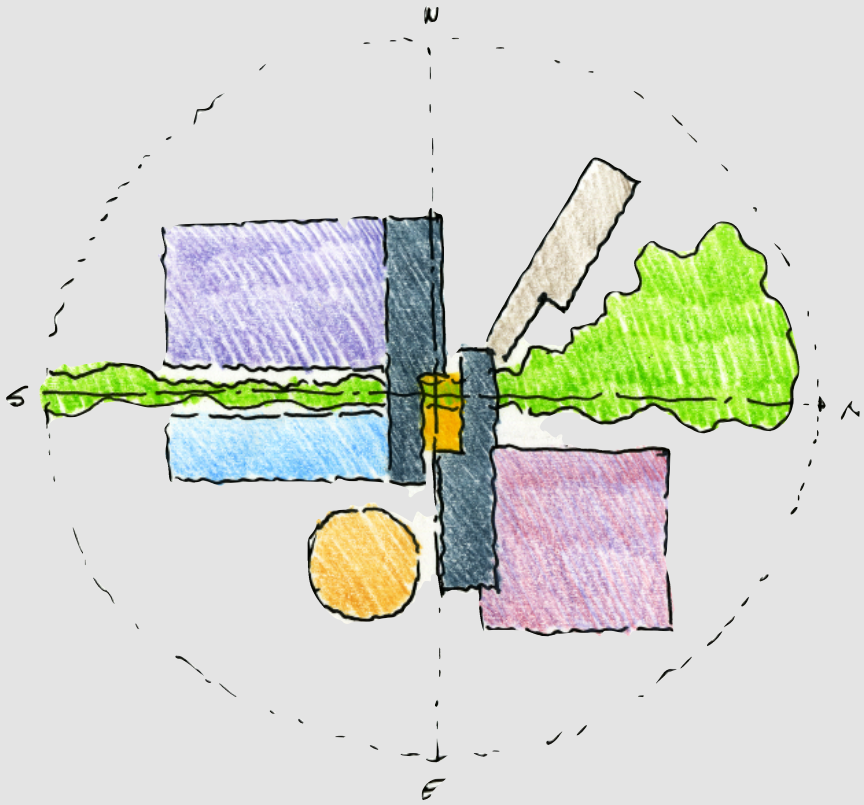
- Principal in Charge (PIC)
  - Usually has the previous client relationship/experience
  - Overall responsibility for the project
  - Selects and lays-out the structural systems
  - Reviews and signs structural drawings
  - Checks critical calculations
  - Financial responsibility
- Project Manager (PM)
  - Day to day responsibility for the project
  - Develops work plan and assigns staff
  - Assists in selection and layout of structural systems
  - Oversees creation of drawings and calculations
- Project Engineers (PE)
  - Responsible for specific engineering systems
  - Creates drawings, details and calculations for specific systems
- Design Engineers (DE)
  - Responsible for specific engineering tasks
  - Creates calculations to support design

Stages of Creating a Building

- Conceptual Design
- Schematic Design
- Design Development
- Construction Documents
- Approval
- Bidding
- Construction

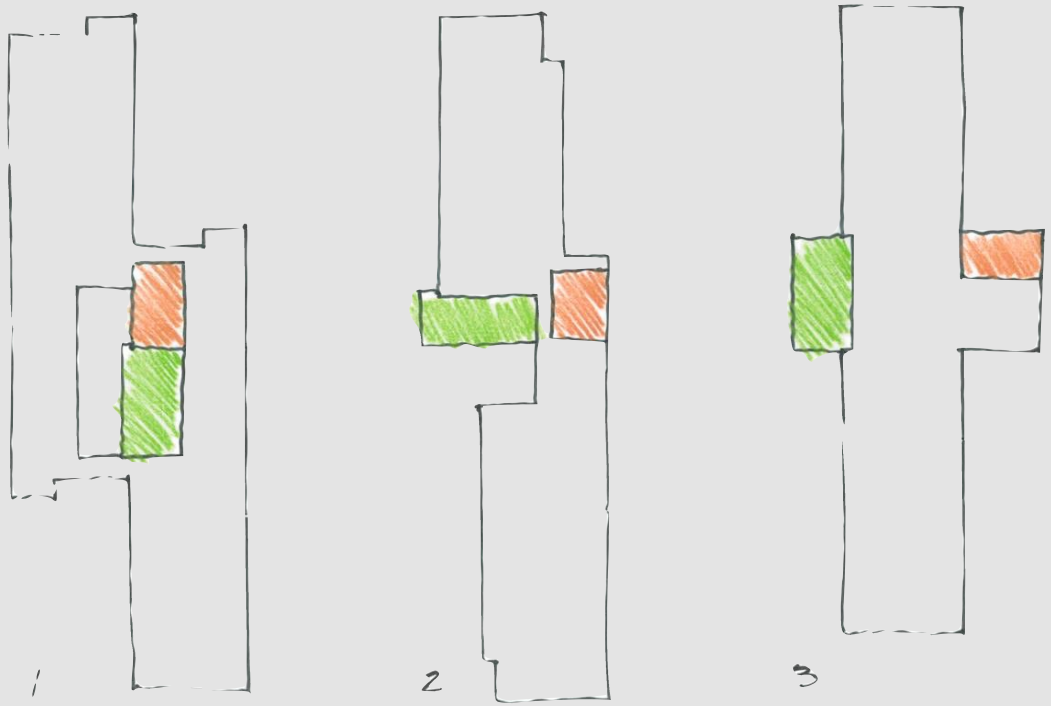
Conceptual Design

- Key Participants
  - Owner
  - Architect
  - Usually no Engineers
- Goals
  - Clarify the Owner's Needs
    - General size & location
    - Use
    - Total Cost
    - General aesthetic appearance



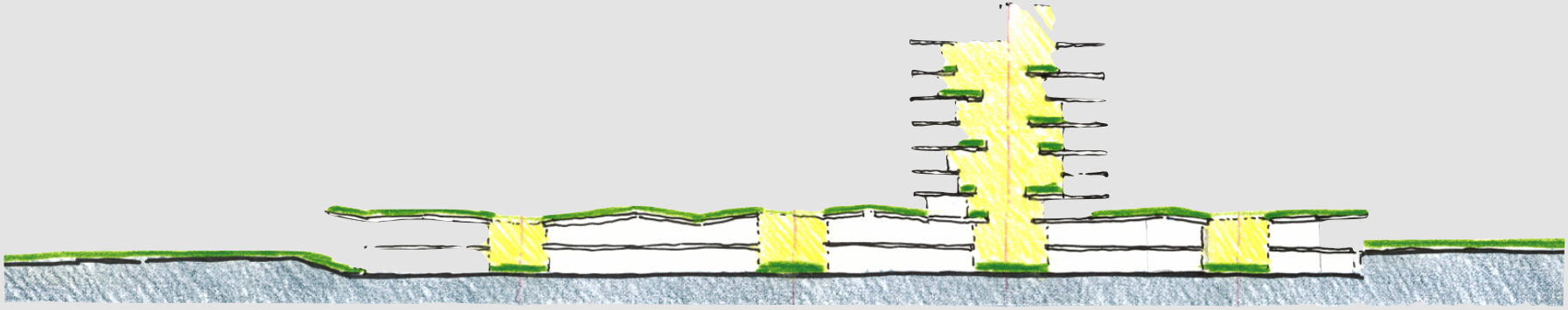
Conceptual Design

- Study Plan Configurations



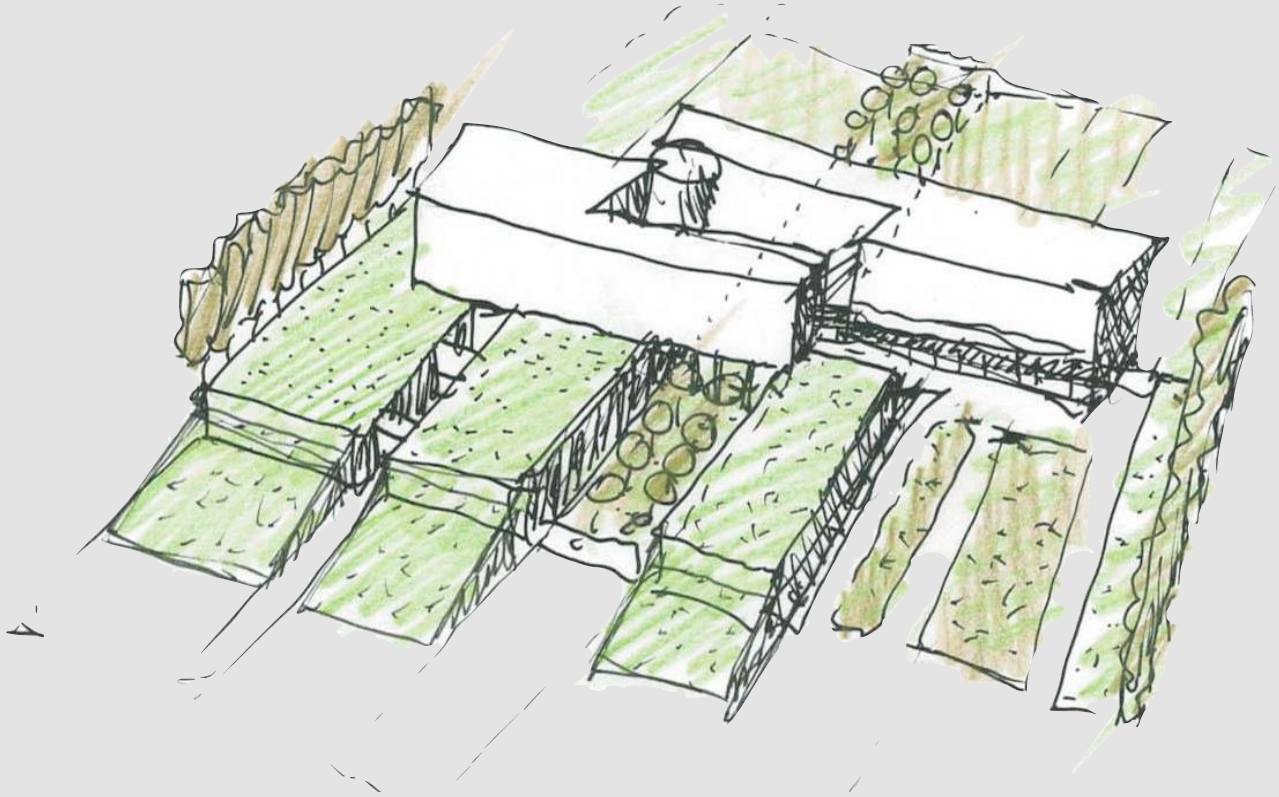
Conceptual Design

- Study Building in Section – Story Heights



Conceptual Design

- Study Massing



Schematic Design/Design Development

- Key Participants
  - Owner
  - Architect
  - Main Engineers (Structural, MEP, Civil)
- Goals
  - Develop Building Design
    - Floor plate, number of stories, story height
    - Column locations
    - Lateral system
    - More developed aesthetic appearance
  - Develop Design & Construction Schedule
  - Refine cost

Hand Renderings

Computer Renderings

Small Scale Models

Programming Diagrams

Lateral System

- Types
  - Steel
    - Braced Frame
    - Moment Frame
    - Shear Wall
    - Buckling Restrained Braced Frame
  - Concrete
    - Moment Frame
    - Shear Wall
  - Masonry
    - Shear Wall
  - Base Isolated
- Preliminary Computer Model

Steel Braced Frame

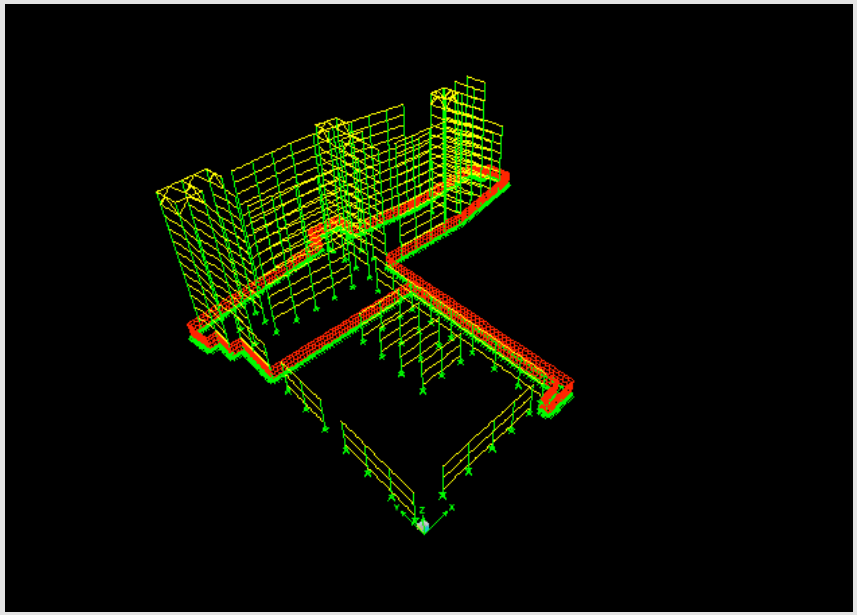
Steel Moment Frame

Concrete Shear Wall

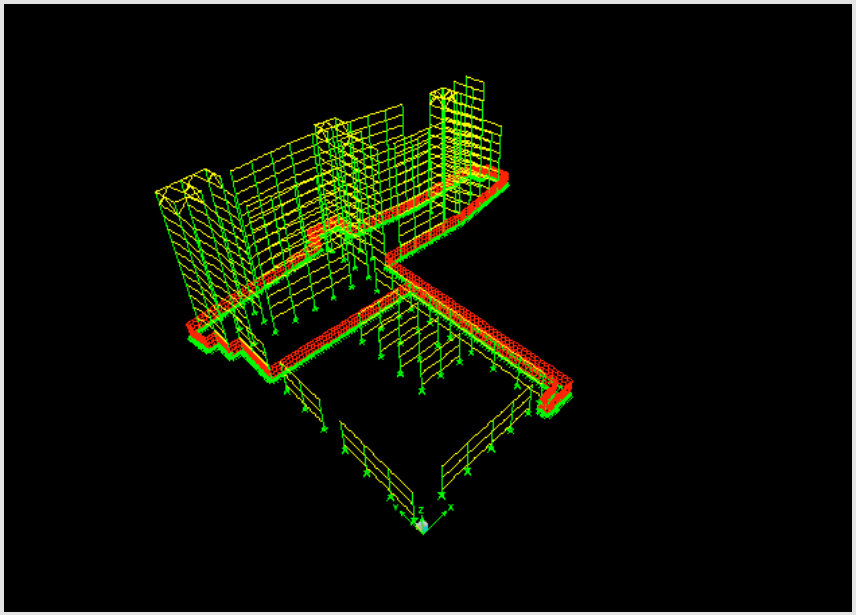
Base Isolation

Preliminary Layout of Lateral System

Preliminary Computer Model



1st Mode: Long Direction



2nd Mode: Short Direction

Construction Documents

- Key Participants
  - Architect
  - Structural Engineer
  - MEP Engineer
  - Civil Engineer
  - Lanscape Architect
  - Medical Planner
  - Equipment Consultant
  - Code Consultant
  - Telecommunications Engineer
  - Fire Alarm Consultant
  - Etc.

- Goals

  Create Construction Documents

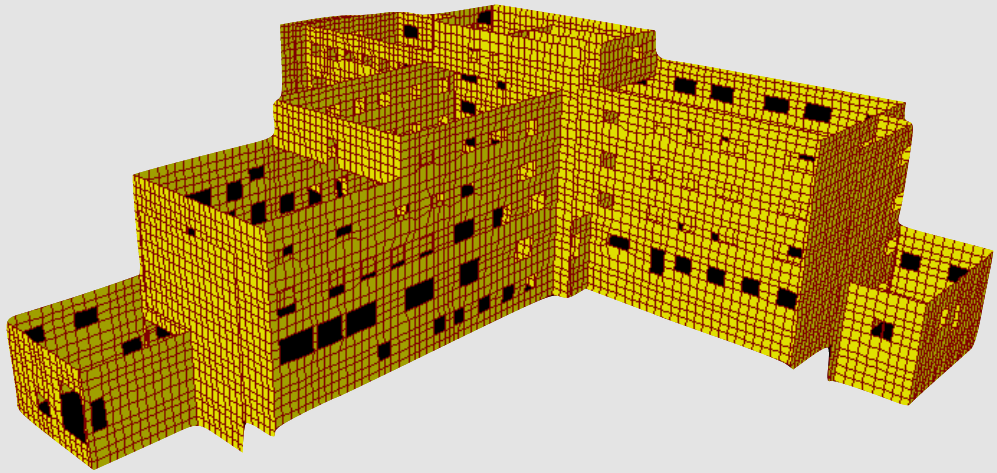
  Plans

  Details

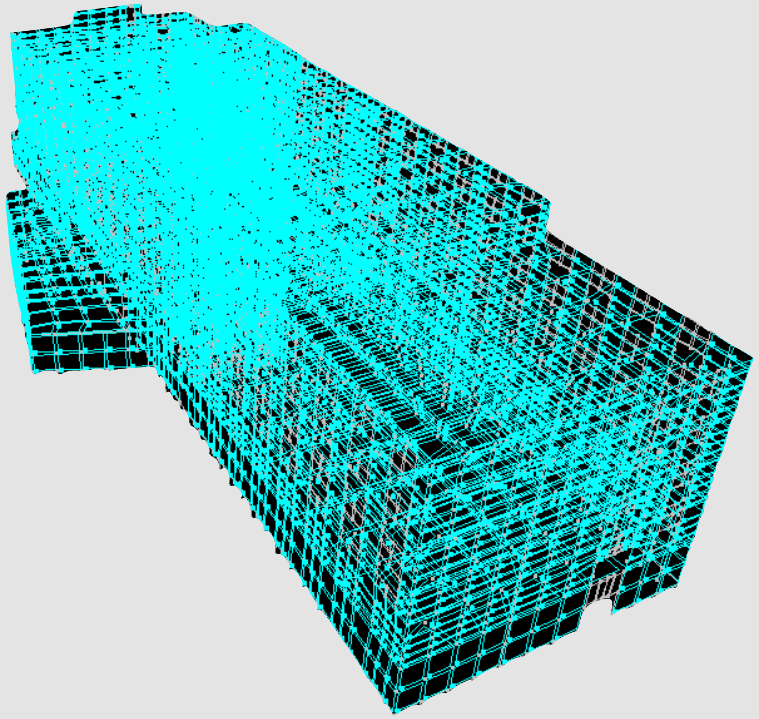
  Specifications

- THE CONSTRUCTION DOCUMENTS ARE OUR PRODUCT
- THE CALCULATIONS ARE MERELY A MEANS TO AN END
- NO ONE BUILDS OFF CALCULATIONS

Detailed Analysis



SAP2000



PERFORM

Detailed Calculations

SCBF CONNECTION DESIGN - DIAGONAL BRACE

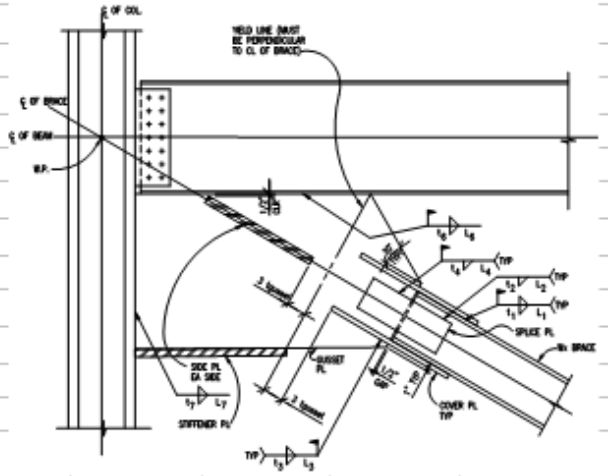
DESIGN ASSUMPTIONS		
Building Code	Seismic Prov. For Struc. Steel Bldgs.	
Story Height (ft)		15
Bay Width (ft)		30
Ω_0		NA
Conn. Plate F_y (ksi)		50
Weld Electrodes		E70XX
R_y		1.1
Gravity Beam Reaction (R_v) =		50 kip

BRACE FORCE IS LESSER OF:		
1) Brace $P_t = F_y A R_y$ =	1458	kip
2) System Force		
P_{gov} =	1458	kip

☐ Roof Frame Beam? Check, if YES.

☑ Is Gusset on Beam Topside? Check, if YES.

Total Concrete Thickness on Topside of Beam = 6.25 in



BRACE DATA	
Shape	W14X90
Area =	26.50 in2
b_f =	15.5 in
T =	11.25 in
t_f =	.71 in
t_w =	.44 in
d =	14.02 in
r_{min} =	3.7 in
F_y (ksi) =	50
Fu (ksi) =	65
	Typ @ WF

COLUMN DATA	
Shape	W14X145
Area =	42.70 in2
b_f =	15.5 in
T =	11.25 in
t_f =	1.09 in
t_w =	.68 in
d =	14.78 in
r_{min} =	3.98 in
F_y (ksi) =	50

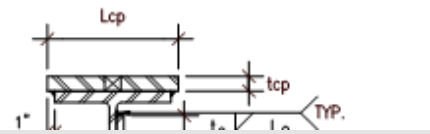
☑ Strong Axis

☐ Weak Axis

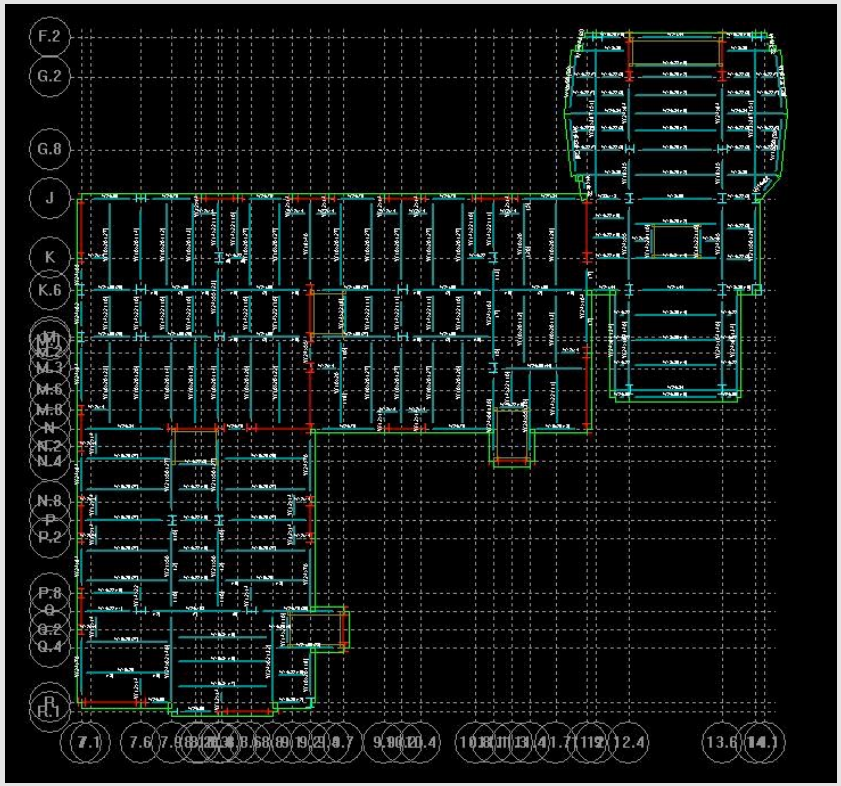
TOP BEAM DATA	
Shape	W30X148
Area =	43.50 in2
b_f =	10.48 in
T =	26.75 in
t_f =	1.18 in
t_w =	.65 in
d =	30.67 in
r_{min} =	2.28 in
F_y (ksi) =	50

BOTTOM BEAM DATA	
Shape	W30X148
Area =	43.50 in2
b_f =	10.48 in
T =	26.75 in
t_f =	1.18 in
t_w =	.65 in
d =	30.67 in
r_{min} =	2.28 in
F_y (ksi) =	50

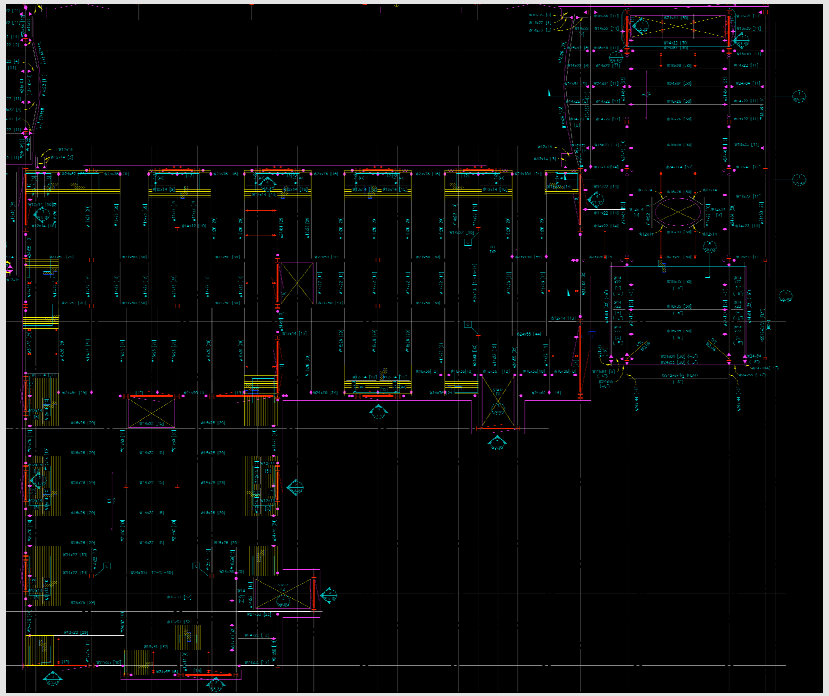
SIZE COVER PLATES AND SPLICE TAB



Model to Drawing

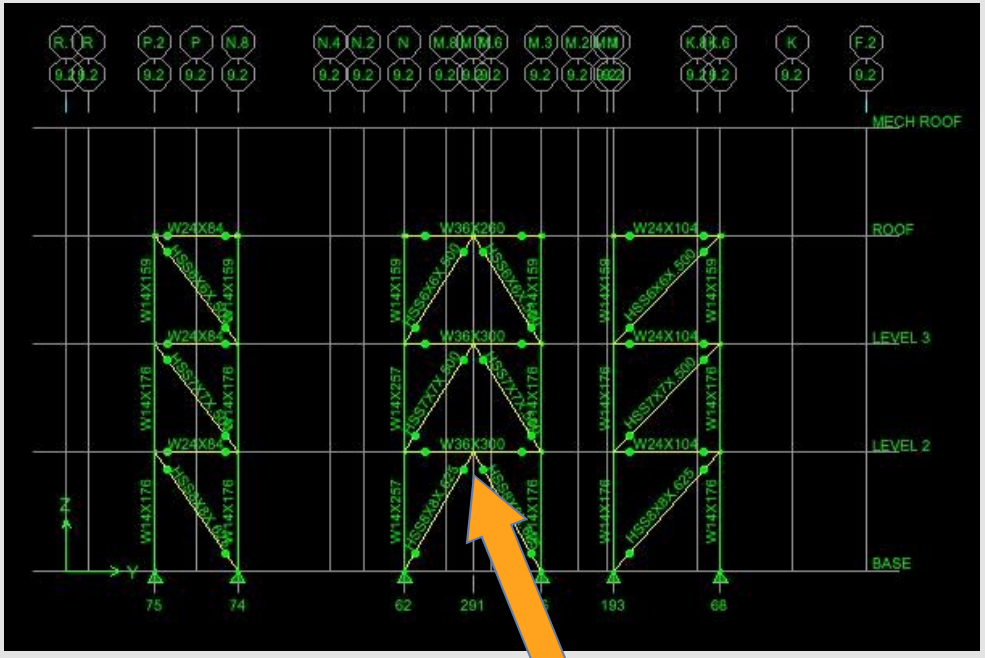


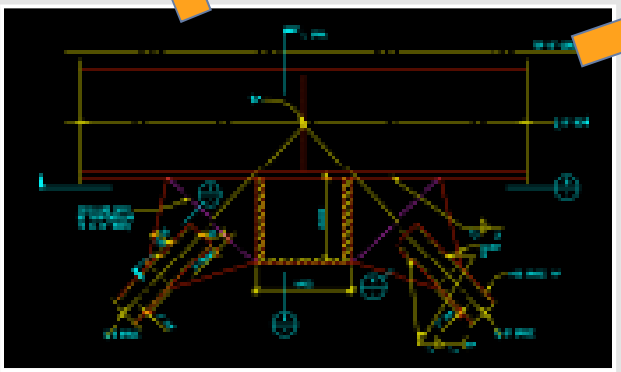
Floor Plan in Computer Design Model

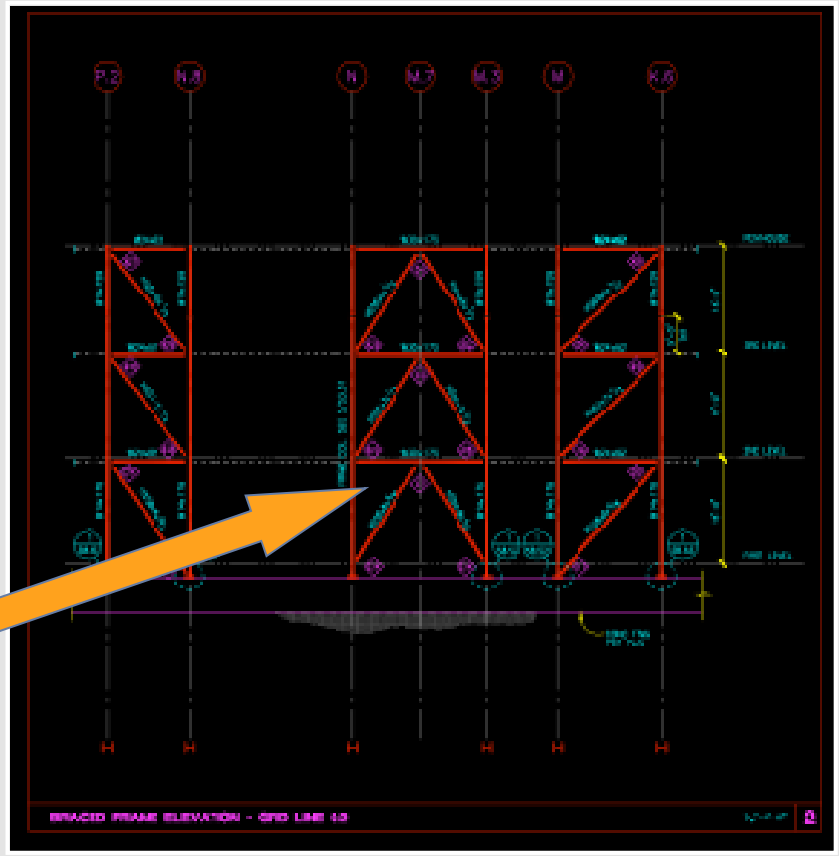


Floor Plan on Structural Building Plans

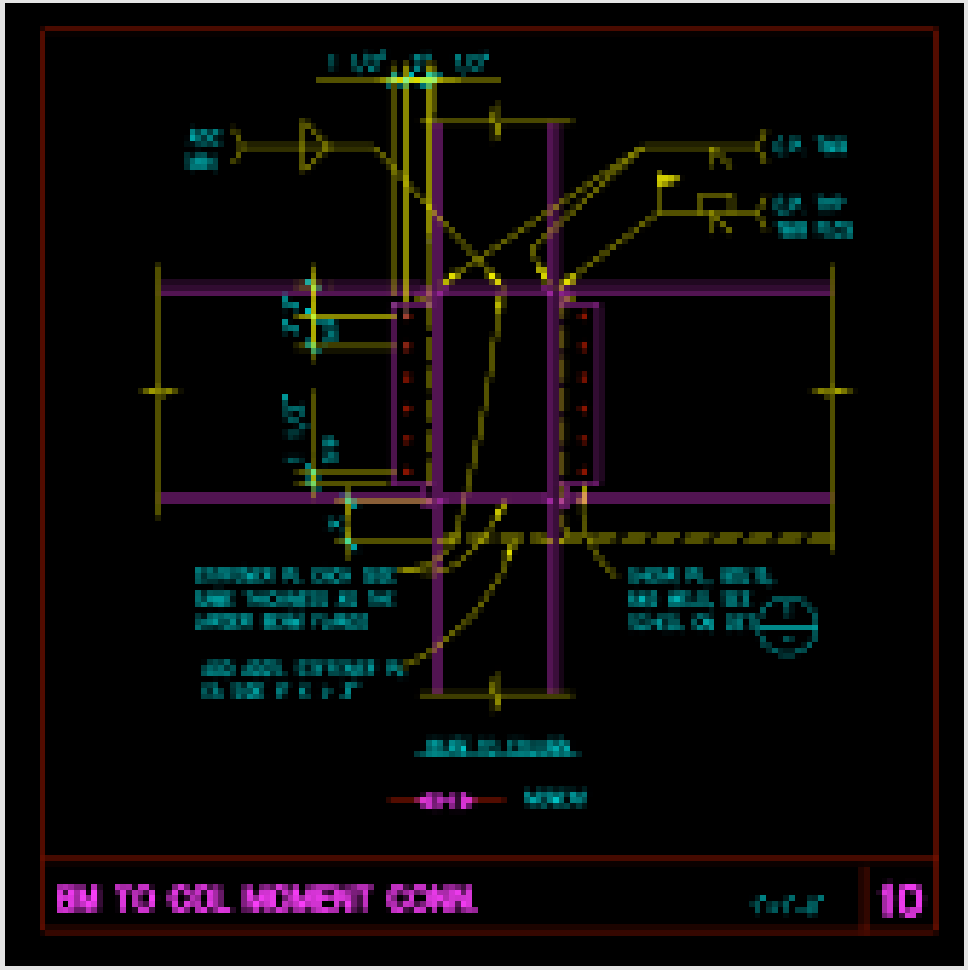
Model to Drawing

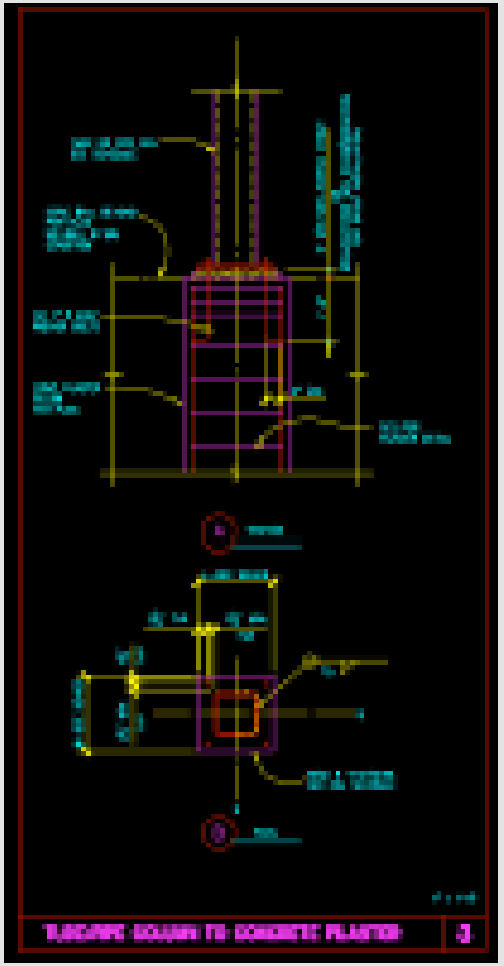






Details

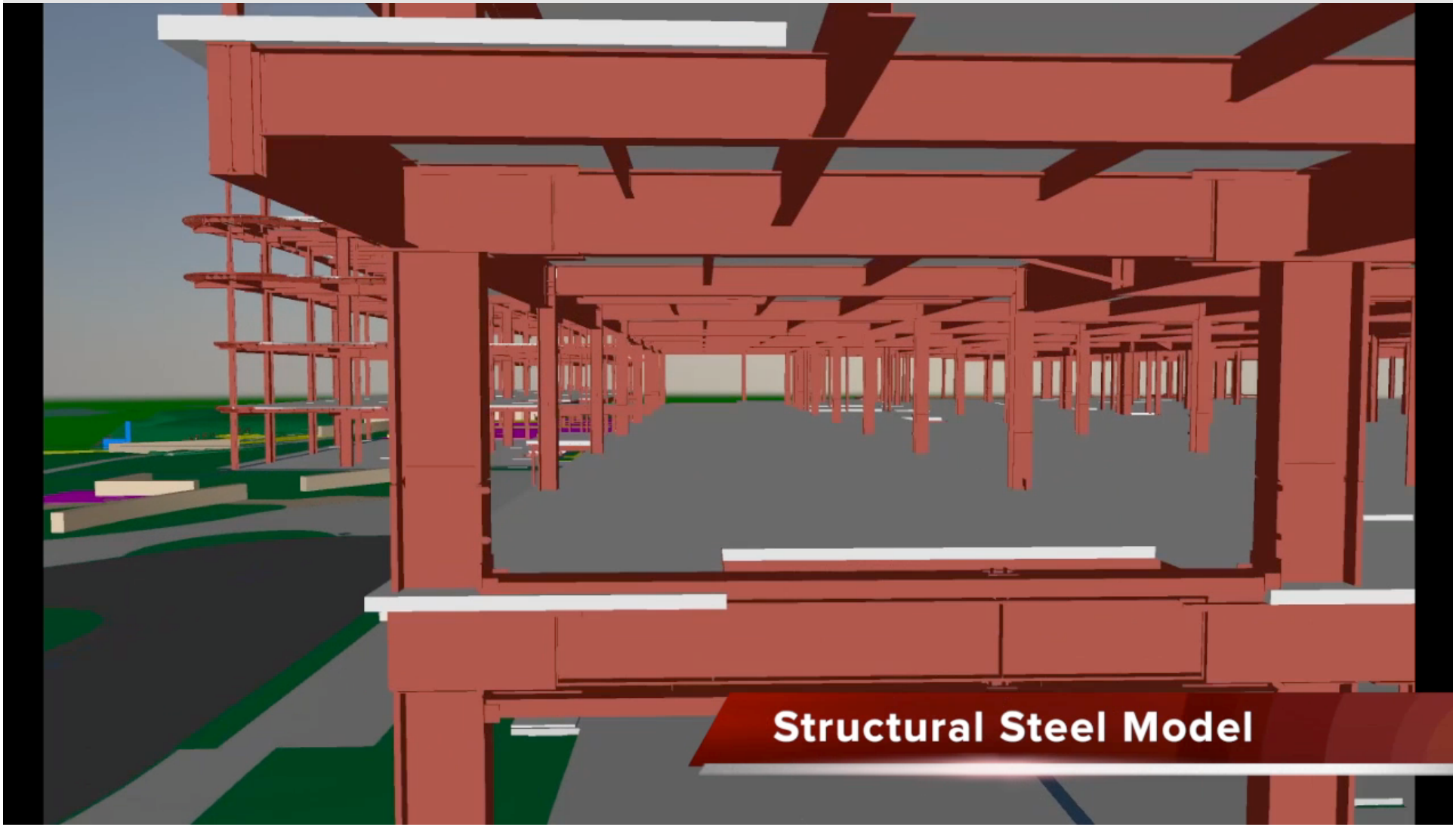




Building Information Modeling

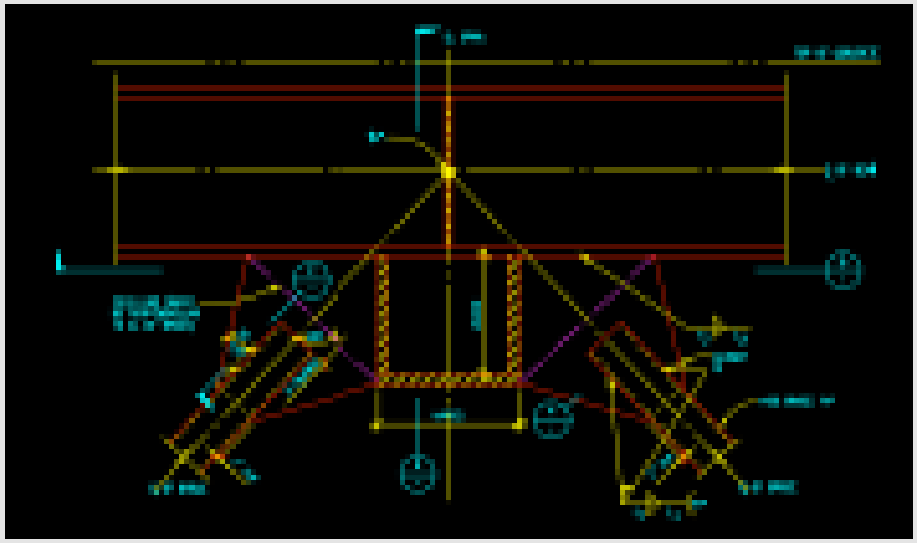
- BIM involves a database of building components which can be utilized for definition and construction of the project:
  - 3D model/renderings
  - Cost models, Bill of materials
  - Construction scheduling
  - Analytical models
  - Coordination between trades

Building Information Modeling



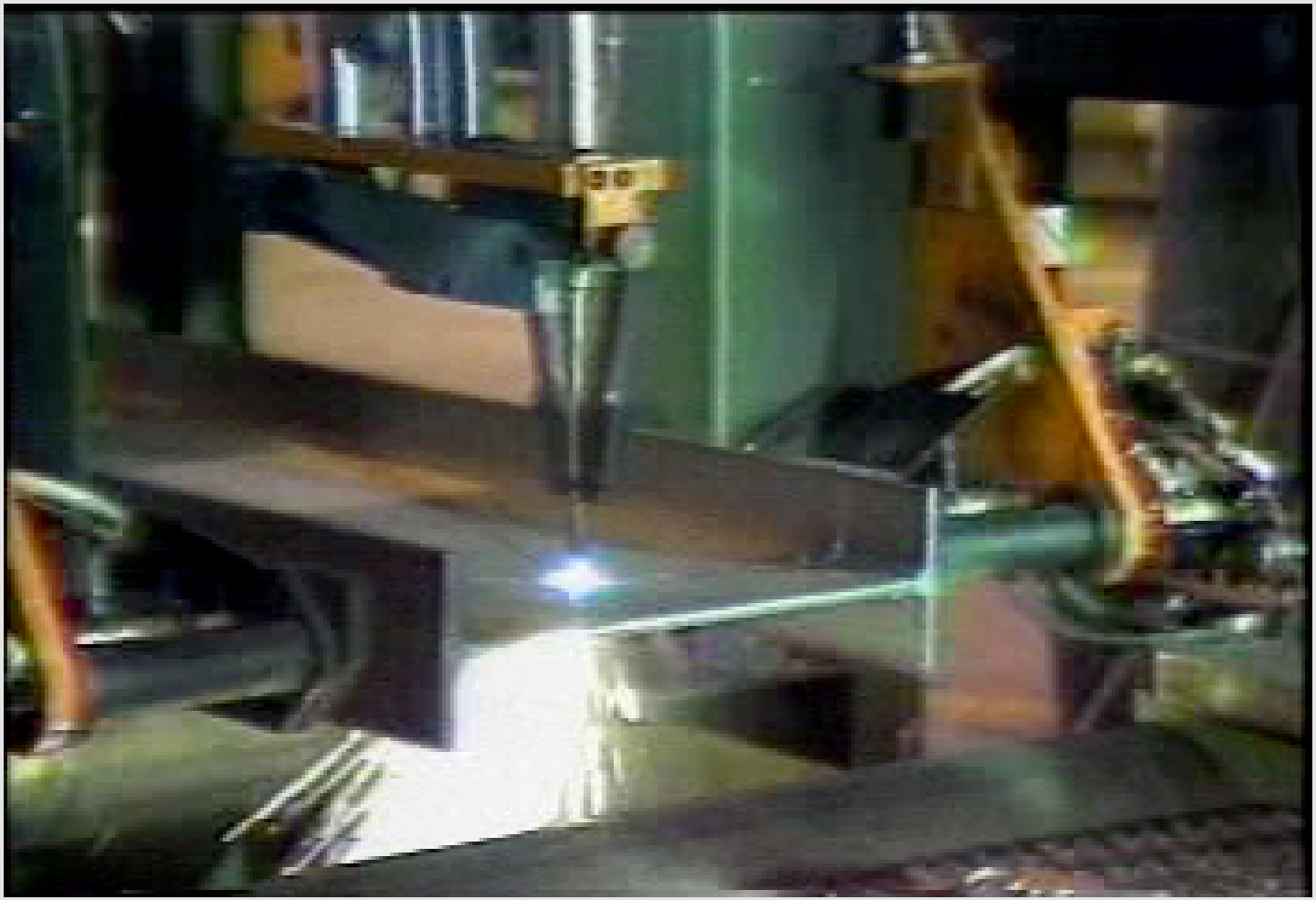
CONSTRUCTION OF STEEL BUILDINGS

Building Construction



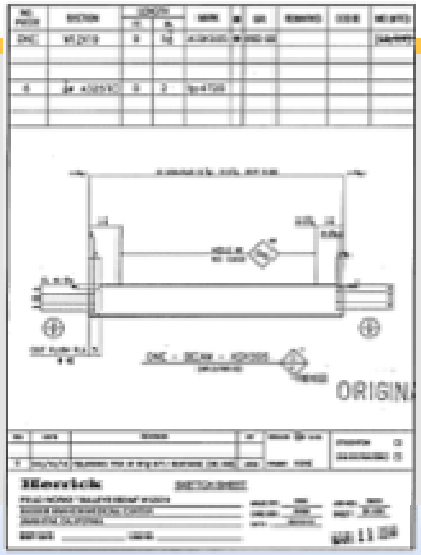
Steel Detailing and Fabrication

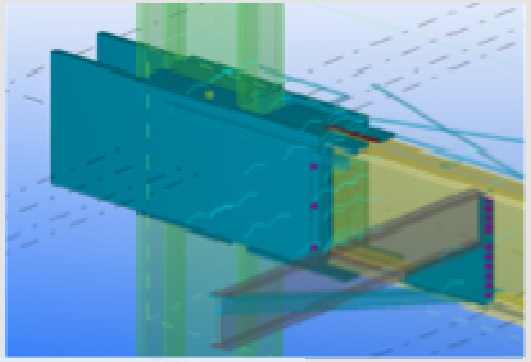
Steel Detailing and Fabrication

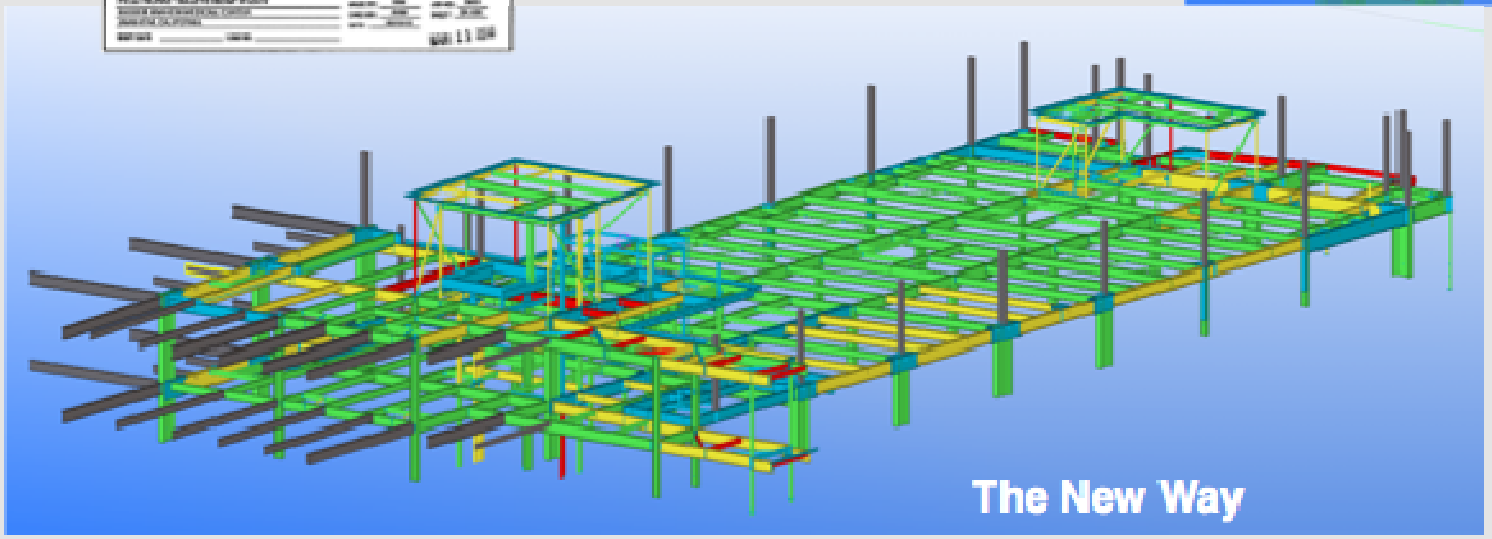


Modern Detailing Practice

The Old Way







Color Legend:
Revise & Resubmit
Approved as Noted
Approved
Review Pending
Not in Submittal

Steel Erection

Steel Erection

Construction

- Key Participants
  - Owner
    - Owner's Representative
    - Construction Manager
  - Design Team
    - Architect
    - Engineers
  - Builders
    - General Contractor
    - Sub-Contractors
    - Inspectors

- Goals

  BUILD IT ON TIME AND ON BUDGET

  Communication is the key

  Construction Meetings

  Requests for Information (RFI)

  Submittals

  Site Visits

  Inspections

  Test Reports

  Change Orders

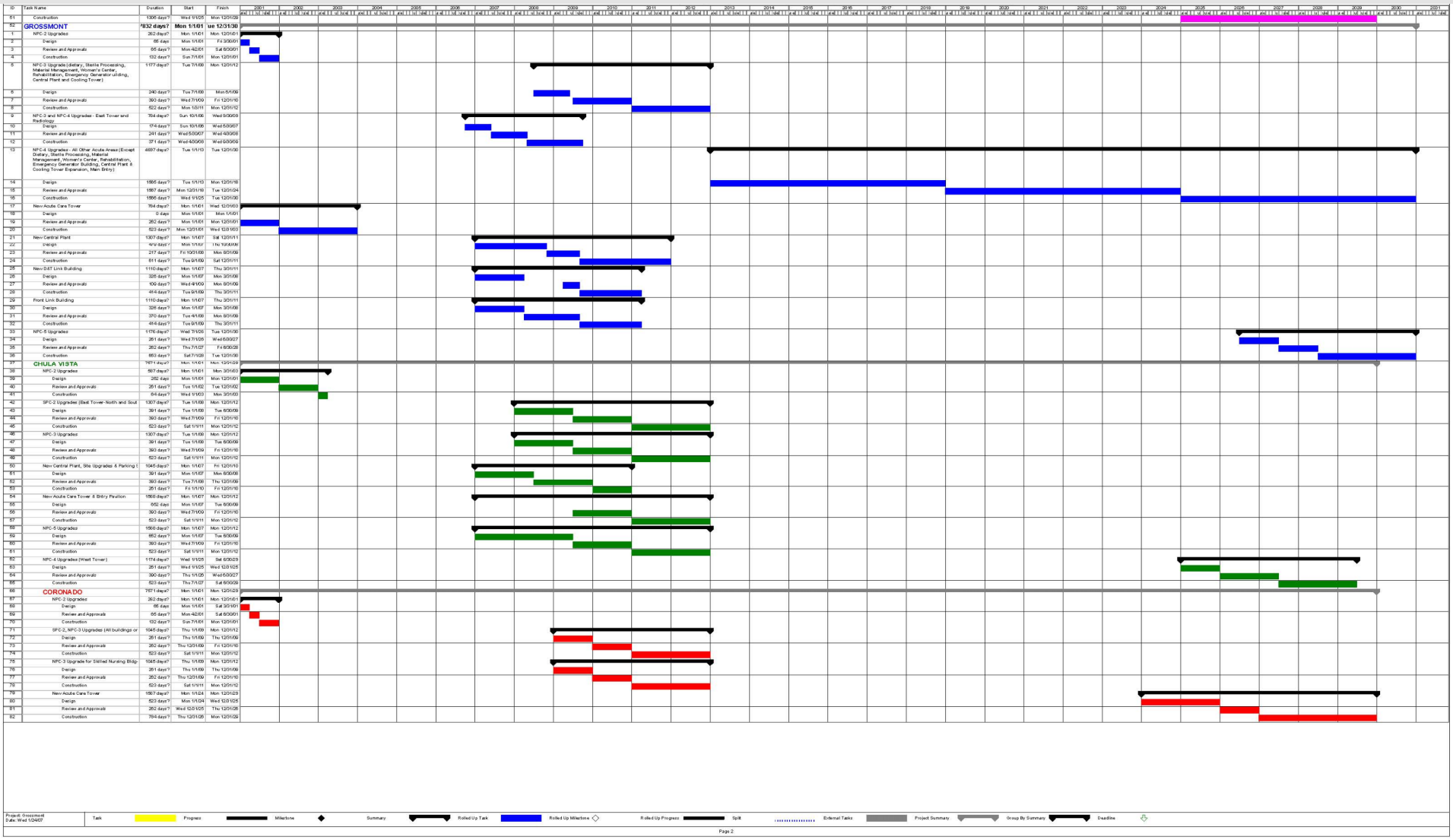
Construction Budget

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Notes
01.01 New Hosp				
01.000-00 FOUNDATIONS	724,260.00 sf	5.64 /sf	4,083,931	
02.000-00 SUBSTRUCTURE	724,260.00 sf	10.03 /sf	7,260,807	
03.000-00 SUPERSTRUCTURE	724,260.00 sf	107.72 /sf	78,014,518	
04.000-00 EXTERIOR WALL ENVELOPE	724,260.00 sf	76.82 /sf	55,634,086	
05.000-00 ROOFING SYSTEM	724,260.00 sf	9.97 /sf	7,224,127	
06.000-00 INTERIOR CONSTRUCTION	648,172.00 sf	144.96 /sf	93,957,790	
07.000-00 CONVEYING	724,260.00 sf	14.65 /sf	10,610,964	
08.000-00 PLUMBING & PROCESS PIPING	724,260.00 sf	49.98 /sf	36,195,899	
09.000-00 FIRE PROTECTION	724,260.00 sf	6.46 /sf	4,679,817	
10.000-00 H.V.A.C.	724,260.00 sf	64.41 /sf	46,652,762	
11.000-00 ELECTRICAL	724,260.00 sf	44.87 /sf	32,496,054	
12.000-00 SPECIAL EQUIPMENT	724,260.00 sf	0.60 /sf	435,000	
14.000-00 JOBSITE MANAGEMENT	724,260.00 sf	39.82 /sf	28,840,000	
15.000-00 SPECIAL REQUIREMENTS	724,260.00 sf	11.36 /sf	8,230,500	
01.01 New Hosp	**724,260.00 sf**	**572.06 /sf**	**414,316,256**	

Partial Totals

Description	Amount	Totals	Rate	
Labor				
Material				
Subcontract	414,316,256			572.05 /sf
Equipment				
Other				
	414,316,256	**414,316,256**		**572.05 /sf**
Bond	8,286,325		2.000 %	
Design Contingency	29,582,181		7.000 %	
Escalation	58,784,019		13.000 %	
Partial Total		***510,968,781***		***705.50 /sf***

Construction Schedule



Construction Schedule